

Assessment of Constraints of Fish Processing and Storage Technologies among Fish Processors and Marketers in Delta State

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Abstract

This study examined the assessment of constraints of fish processing and storage technologies among processors and marketers in Delta State, Nigeria. The objectives were to describe the socio-economic characteristics of respondents, assess their awareness of fish processing and storage technologies, and identify the most frequently used technologies and associated constraints. A total of 180 respondents were selected through simple random, snowball, and purposive sampling techniques, and data were collected using structured questionnaires. Analysis was conducted using frequency counts, percentages, and mean rankings. Results revealed that 61.7% of respondents were female, 81.1% were married, and the mean household size was five persons. About 47.2% had secondary education, while 42.8% sourced capital from cooperatives. Locally fabricated smoking kilns were the most commonly used (34.4%), but were constrained by cuts, burns, and stressful use. For modern smoking kilns, high cost and poor access to improved technologies were the most critical challenges. The study concludes that although modern technologies such as the NSPRI smoking kiln and iced fish box offer improved efficiency and product quality, their adoption remains low due to high costs, limited awareness, and poor accessibility. It is recommended that government agencies, research institutes, and development partners intensify efforts in developing and disseminating affordable and user-friendly technologies, strengthening extension services, providing financial support, and implementing gender-sensitive policies to reduce post-harvest losses and improve the livelihoods of small-scale fish processors in Delta State.

Keywords:

Constraints, fish handlers, post-harvest losses, technologies

Introduction

Fish is a vital contributor to global food security and nutrition, serving as a major source of high-quality protein, essential fatty acids, vitamins, and minerals that are critical for human health (FAO, 2022). In tropical regions, particularly in Nigeria, fish represents a staple source of animal protein, supplying more than 40% of total animal protein intake in many coastal and riverine communities (Oladimeji et al., 2023). The activities that take place between the harvesting of fish and its delivery to consumers, collectively referred to as fish processing and storage, are crucial for ensuring food safety, extending shelf life, and maintaining economic value (FAO, 2021).

However, fish is one of the most perishable animal protein sources, beginning to deteriorate almost immediately after capture due to microbial activity and enzymatic degradation (Okorie et al., 2021). Without adequate preservation measures, significant post-harvest losses occur, contributing to reduced incomes for processors and marketers and limiting protein availability for consumers (Akinola et al., 2022). Global fish consumption has been rising faster than population growth, driven by heightened awareness of its health benefits, increasing incomes, and urbanization (Rondanelli et al., 2020; Issifu et al., 2022). This growth highlights the need for sustainable, efficient, and

scalable fish processing and storage systems, particularly in developing countries where infrastructure deficits persist as a challenge (FAO, 2022).

Traditional fish processing in Nigeria is dominated by smoking, which is widely preferred for its ability to enhance flavor, increase shelf life, and generate higher market value (Akinyemi et al., 2024). Locally fabricated smoking kilns and open-fire methods remain prevalent due to their affordability and accessibility, particularly among small-scale processors, who are predominantly women (FAO, 2020; Eyo et al., 2023). In West Africa, over 80% of processed fish is smoked, with the remainder preserved by frying, salting, or sun-drying (Adeyeye et al., 2015). Women play a dominant role in the post-harvest fisheries sector, accounting for up to 70% of processing and marketing labor, which has socio-economic implications for household income and gender empowerment (Oladimeji et al., 2023).

The fisheries sector plays a crucial role in ensuring food security, providing livelihoods, and contributing to Nigeria's economy. However, despite its importance, post-harvest losses in fish remain alarmingly high, with estimates indicating that 20–30% of artisanal fish harvests are lost annually due to inadequate processing and storage methods (Akinola et al., 2022; Oladimeji et al., 2023). These losses are particularly severe in Delta State, where fishing is a major source of income for riverine communities. Yet, the sector is constrained by infrastructural deficits, limited access to modern technologies, and inadequate extension services (Eyo et al., 2023).

Despite these socio-economic contributions, persistent challenges hinder the adoption of modern fish processing and storage technologies. These include high equipment costs, inadequate access to credit, limited awareness of improved technologies, insufficient extension services, and infrastructural deficits such as unreliable electricity and poor transportation (Eyo et al., 2023; Williams et al., 2024). Modern technologies, such as the NSPRI fish smoking kiln and iced fish boxes, offer improved efficiency, reduced health hazards, and enhanced product quality. Still, their uptake remains low among rural processors (Oladimeji et al., 2023). This technology adoption gap continues to contribute to post-harvest losses estimated at 20–30% in Nigeria's artisanal fisheries sector (Akinola et al., 2022). Addressing these challenges requires a holistic approach that combines the dissemination of technology, capacity building, financial support, and gender-sensitive interventions.

Understanding the constraints faced by fish processors and marketers is crucial for designing context-specific strategies that enhance product quality, mitigate economic losses, and improve livelihoods throughout the fisheries value chain. This study proffers solutions to socio-economic characteristics of the respondents, awareness level of fish processing and storage technologies, and the most frequently used fish processing and storage technology.

Methodology

Study area

The research was carried out in Delta State, Nigeria, which produces oil and agricultural products. It is situated in the South-South Geopolitical Zone and has 4,112,445 inhabitants, including 2,069,309 men and 2,043,136 women. The capital city is Asaba, Delta State, and its surrounding areas are ideal for fishing due to their position in Nigeria. The fishing settlements are distributed with numerous types of water features, including lagoons, rivers, creeks, and marshes. As a result, the majority of the residents of the chosen localities rely on fishing, fish processing, and fish marketing as sources of income.

Population of the study

The population for the study consisted of all the fish processors and marketers from selected local government areas of Delta State.

Sampling procedure and sample size

A multistage sampling technique was used for the study. Firstly, one Local Government Area per agricultural zone in Delta state was purposively selected based on the abundance of fish processing and marketing activities; hence, Sapele, Oshimili North, and Warri North Local Government Areas were selected from Delta South, Delta Central, and Delta North Agricultural Zones, respectively. Secondly, the snowballing technique was employed to generate 180 sample size for the study. A structured questionnaire/interview was used in collecting primary data for the study. To attain the objectives stated for the study, descriptive statistics were employed to analyze the data collected. The descriptive statistical tools used are: frequency, percentage, and mean.

Results and Discussion

Socio-economic characteristics of respondents

The result in Table 1 shows that the majority (61.7%) of the respondents were females. This implies that the proportion of females was higher than that of males in

fish processing and marketing in the study area. The result corroborated Adegbola et al. (2020), who reported that female-dominated fish processing activities exist in Osun State.

The mean age of the respondents was 43 years; this implies that the age of fish processors and marketers in the study area is within the active age bracket, which could lead to more participation in fish production and marketing activities. The age of a fish handler can generate or erode confidence in the adoption of improved storage techniques. This is similar to the result obtained by Omitoyin et al. (2020) in their research, titled "Gender participation in aquaculture in Lagos state, Nigeria which reported that the majority of fish handlers in Lagos state had an age range of 31-60 years.

Marital status of the respondents revealed that the majority (81.1%) were married. This suggests that most married women are actively involved in fish processing and marketing activities, as they rely on the income generated from these ventures to support household responsibilities and family needs. This

finding corroborates the report by Akinyemi et al. (2024), who observed that dried catfish marketers in Nigeria were married, thereby underscoring the significant role that marital responsibilities play in motivating women's participation in fish marketing enterprises.

The educational level of the respondents indicated that a secondary educational background (47.2%) was the most common. This suggests that the majority of respondents had functional education, which bodes well for the adoption of improved technology, given the sufficient literacy among the processors/marketers. This result aligns with more recent findings. Amengor et al. (2022) observed that formal education was positively correlated with farmers' awareness and adoption of technology, suggesting that higher educational attainment facilitates the uptake of innovation and effective information use. Household size indicates that the average household consisted of approximately five persons. This suggests that larger households may increase participation and labour availability in fish processing and marketing activities.

Table 1: Socio-Economic Characteristics of Respondents

Variable	Frequency	Percentage	Mean
Gender			
Male	69	38.3	
Female	111	61.7	
Age			
21-30	19	10.6	43.55
31-40	58	32.2	
41-50	63	35	
51-60	32	17.8	
61-70	8	4.4	
Marital Status			
Single	19	10.6	
Married	146	81.1	
Divorced	7	3.9	
Widowed	8	4.4	
Household Size			
1-5 Persons	117	65	4.98
6-10 Persons	63	35	
Level of Education			
No Formal Education	21	11.7	
Primary Education	54	30	
Secondary Education	85	47.2	
Tertiary	20	11.1	
Years of Experience			
1-10 years	11	6.1	15.22
11-20 years	52	28.9	
21-30 years	43	23.9	
31-40 years	74	41.1	

Source: Field Survey 2025

This aligns with Ajibade et al. (2022), who found that fish marketers in Nigeria had an average household size of 5 persons. That household size had a significant influence on profitability in fish processing and marketing.

The years of experience of the respondents show a mean of 15.22. This indicates that there are more experienced fish handlers in the study area, and this is also expected to affect their awareness of modern technologies. This outcome is consistent with a study by Odeiran and Ojebiyi (2017), who found that more experienced fish processors will be able to make a clear and reasonable decision about adopting a technology based on their extensive understanding of current technologies compared to newly introduced ones.

Awareness of fish processing/storage technologies

As shown in Table 2, it was found that all (100%) respondents are aware of perforated baskets and basins, the majority (88.9%) are aware of the refrigerator, 67.8% are aware of the locally fabricated smoking kiln, 33.3% of the respondents are aware of the NSPRI fish smoking kiln, and the NSPRI iced fish box. In comparison, 32.2% are aware of the modern smoking kiln. The result reveals that the majority of the respondents sampled are aware of locally fabricated smoking kilns. This result suggests that further efforts are needed to raise awareness about the adoption of modern processing technologies in the study area by relevant technology-generating centers. This result is supported by Alabi et al. (2020), who stated that fish processors were not aware of improved smoking equipment, highlighting how insufficient awareness impedes adoption despite potential benefits.

Table 2: Awareness of fish processing/storage technologies

Variables	Yes	No
Locally Fabricated Smoking Kiln	122(67.8)	58(32.2)
Modern smoking kiln	58(32.2)	122(67.8)
NSPRI Fish Smoking Kiln	60(33.3)	120(66.7)
NSPRI Iced Fish Box	60(33.3)	120(66.7)
Perforated basket	180(100)	0(0)
Basin	180(100)	0(0)
Refrigerator	160(88.9)	20(11.1)

Source: Field Survey, 2025

As shown in Table 3, the locally fabricated smoking kiln was the most frequently used (34.4%), followed by the Modern Smoking Kiln (17.2%), and NSPRI Fish Smoking Kiln (13.3%). The result showed that the majority of fish handlers use locally fabricated

smoking kilns, which have posed a threat to their finished products and also reduced their income. This finding agrees with (Adeyeye et al., 2021; Akinola et al., 2022) recent evidence showing that small-scale processors in Nigeria continue to rely heavily on locally available smoking technologies (mud-brick and drum kilns, firewood fuels, and simple racks). Such traditional systems remain dominant because they are low-cost and locally repairable. Still, they are energy-inefficient, generate harmful smoke and polycyclic aromatic hydrocarbons (PAHs), and often produce smoked fish of variable and lower sanitary and sensory quality compared with improved kilns.

Table 3: Frequently used types of fish processing and storage technologies

S/N	Types of Technology	Frequency	Percentage (%)
1.	Locally Fabricated Smoking Kiln	62	34.4
2.	Modern Smoking Kiln	31	17.2
3.	NSPRI Fish Smoking Kiln	24	13.3
4.	NSPRI Ice Fish Box	15	8.3
5.	Perforated Baskets	22	12.2
6.	Basin	12	6.7
7.	Refrigerator	14	7.8

Source: Field Survey 2025

Constraints to the use of fish processing and storage technologies

As shown in Table 4, constraints are associated with the use of a locally fabricated smoking kiln. Injuries from cuts and burns (x=3.98) and stressful to use (x=3.78), these variables ranked 1st and 2nd, respectively. This implies that the respondent obtains injuries from cuts and burns and finds it stressful to use the locally fabricated smoking kiln. This is in line with Olaitan et al. (2024), who reported that traditional processing methods pose serious health risks not only to consumers of the products but also to handlers of the technology. Result obtained from the modern smoking kiln indicated that the High Cost of the technologies (x=3.29) and Poor access to improved technologies (x=2.61) ranked 1st and 2nd respectively, for modern smoking kilns. This indicated that the price of modern technologies is extremely high for the respondents, and they could not afford to purchase them to improve their processing and storage abilities. This is supported by Williams et al. (2024), who stated that the effective adoption and use of emerging technologies hinges on raising widespread awareness and deploying efficient dissemination strategies. As shown in Table 5, the data

collected on constraints of Locally Fabricated Smoking Kiln, Modern Smoking Kiln, NSPRI Smoking Kiln, NSPRI Iced Fish Box, Perforated Baskets, Basin, and Refrigerator were subjected to Analysis of Variance. There was a significant

difference in constraints between Locally Fabricated Smoking Kiln, Modern Smoking Kiln, NSPRI Smoking Kiln, NSPRI Iced Fish Box, Perforated Baskets, basin, and Refrigerator ($F=12.489$; $p<0.05$).

Table 4: Constraints to use of fish processing and storage technologies

<i>Locally Fabricated Smoking Kiln</i>	<i>Mean Score LFSK</i>	<i>Rank LFSK</i>	<i>Mean Score MSK</i>	<i>Rank MSK</i>	<i>Mean Score NSPRIFSK</i>	<i>Rank NSPRIFSK</i>	<i>Mean Score NSPRIIFB</i>	<i>Rank NSPRIIFB</i>
<i>Poor awareness of the technologies</i>	1.00	13 th	1.00	14 th	3.42	2 nd	3.38	1 st
<i>Insufficient capital</i>	2.63	5 th	2.00	3 rd	3.38	4 th	2.38	4 th
<i>Poor access to the improved technologies</i>	3.07	3 rd	2.61	2 nd	3.42	2 nd	3.00	2 nd
<i>High Cost of the technologies</i>	1.90	10 th	3.29	1 st	4.00	1 st	3.00	2 nd
<i>Inadequate demand</i>	2.00	6 th	2.00	3 rd	1.79	8 th	1.62	7 th
<i>High market price/ Price fluctuation</i>	2.00	6 th	1.75	9 th	2.00	6 th	2.00	5 th
<i>Inadequate knowledge of processing/storage</i>	1.00	13 th	1.75	9 th	1.46	11 th	1.38	10 th
<i>Stressful to use</i>	3.78	2 nd	1.59	11 th	1.00	13 th	1.00	12 th
<i>Injuries from cuts and burns</i>	3.98	1 st	2.00	3 rd	1.42	12 th	1.00	12 th
<i>Economically non-profitable</i>	2.00	6 th	1.00	14 th	1.00	13 th	1.62	7 th
<i>Fear of taking risks</i>	1.00	13 th	2.00	3 rd	2.79	5 th	1.00	12 th
<i>Poor linkages to extension contact</i>	2.00	6 th	2.00	3 rd	2.00	6 th	2.00	5 th
<i>Lack of interest in the technology</i>	2.85	4 th	1.59	11 th	1.00	13 th	1.00	12 th
<i>Complexity</i>	1.48	11 th	1.35	13 th	1.71	9 th	1.38	10 th
<i>Technical inability</i>	1.17	12 th	2.00	3 rd	1.63	10 th	1.62	7 th

Source: Field Survey 2025

Table 5: Analysis of Variance (ANOVA) to test the difference between the locally fabricated smoking kiln and other selected technologies

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	7228.163	6	1204.694	12.489	.000
Within Groups	120865.750	1253	96.461		
Total	128093.913	1259			

Conclusion

The study highlights the crucial role of fish processing and storage technologies in ensuring food security, improving livelihoods, and reducing post-harvest losses in Delta State, Nigeria. Given the increasing reliance on fish as an alternative protein source amidst declining availability of other animal proteins, the importance of effective and sustainable processing and storage techniques cannot be overstated.

Despite the existence of modern fish processing technologies such as the NSPRI smoking kilns and iced fish boxes, the study revealed that a significant proportion of fish processors and marketers continue to rely heavily on locally fabricated smoking kilns. This preference is primarily attributed to factors such as limited awareness, high cost of modern technologies, poor access, and insufficient extension services. The use of traditional methods, although accessible, exposes users to occupational hazards such

as burns and cuts, and yields lower-quality products with reduced shelf life, ultimately affecting income and marketability.

Conversely, modern technologies offered better outcomes but remained underutilized due to economic and informational barriers. This study highlights a critical technology adoption gap fueled by inadequate dissemination, financial constraints, and socio-economic limitations. Addressing these issues requires a coordinated effort from government agencies, research institutions, extension agents, and development partners. Enhancing awareness, improving accessibility, subsidizing the cost of modern equipment, and integrating gender-sensitive strategies are necessary to bridge this gap. Ultimately, closing this technological divide will not only reduce post-harvest losses and improve food safety but also elevate the socio-economic standing of fish processors, particularly women, who represent the majority in the sector. Therefore, proactive policies and targeted interventions are essential to promote the widespread adoption of improved fish processing and storage technologies across Delta State and beyond.

Recommendations

To enhance fish processing and storage practices and minimize post-harvest losses in Delta State, the following recommendations are made:

- Promotion of Improved Technologies.** Relevant government agencies, research institutes, and development partners should intensify their efforts in developing, refining, and disseminating affordable, efficient, and locally adaptable fish processing and storage technologies. These innovations should aim to extend shelf life, improve product quality, and reduce economic losses.
- Increased Extension Services and Awareness Campaigns.** There is a pressing need for regular and widespread sensitization campaigns led by extension agents to raise awareness about modern fish processing and storage technologies. These campaigns should be designed to reach rural processors and marketers, especially women, who dominate the sector.
- Subsidized and Timely Distribution of Technologies.** Government and donor agencies should facilitate the timely and equitable distribution of modern fish processing and storage equipment, such as NSPRI fish smoking kilns and iced fish boxes.

Subsidies or loan schemes should be introduced to improve affordability and encourage adoption.

- Capacity Building and Training Programs.** Structured training workshops should be organized for fish processors and marketers to build their technical skills in handling and maintaining modern processing and storage technologies. Special focus should be placed on safety, hygiene, and product quality enhancement.
- Strengthen Institutional Linkages.** Stronger partnerships should be fostered between research institutes, extension services, and grassroots processors to ensure continuous feedback, innovation dissemination, and adoption of best practices in the field.

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